Analysis of Nb_3Sn Strands and Cables Performances

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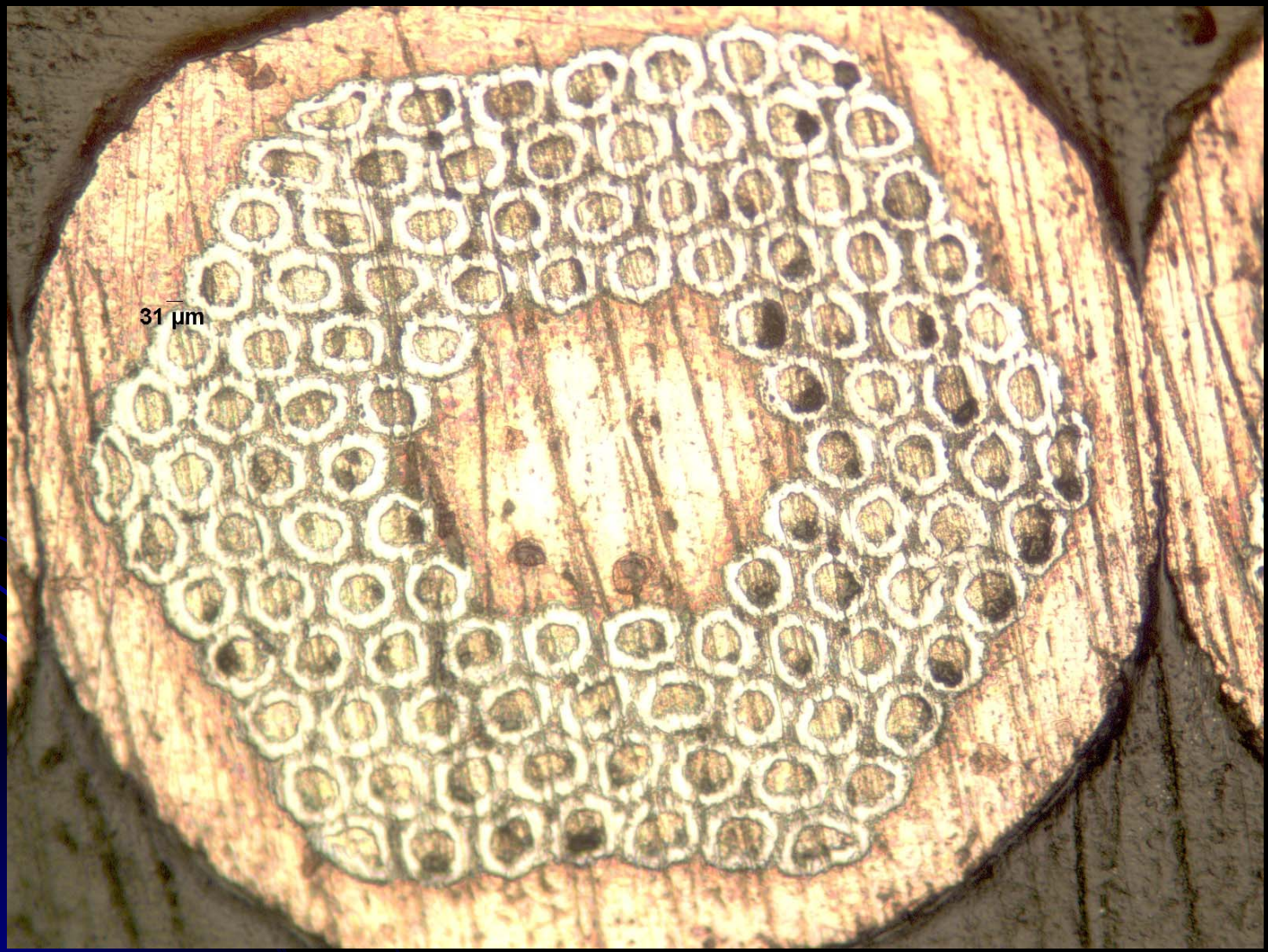
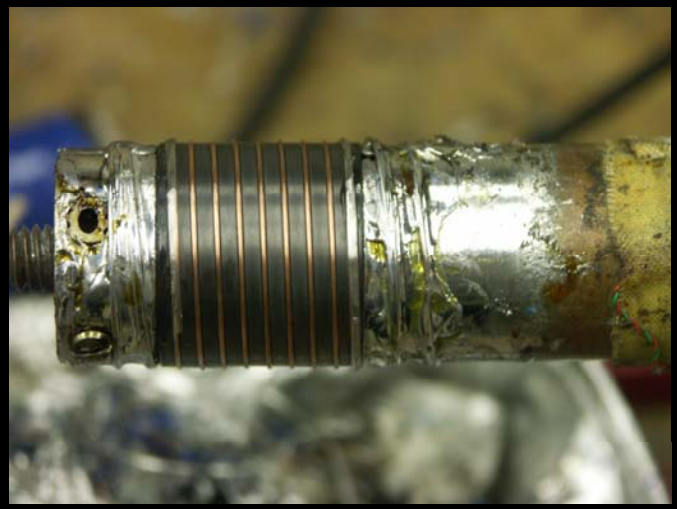
Main points

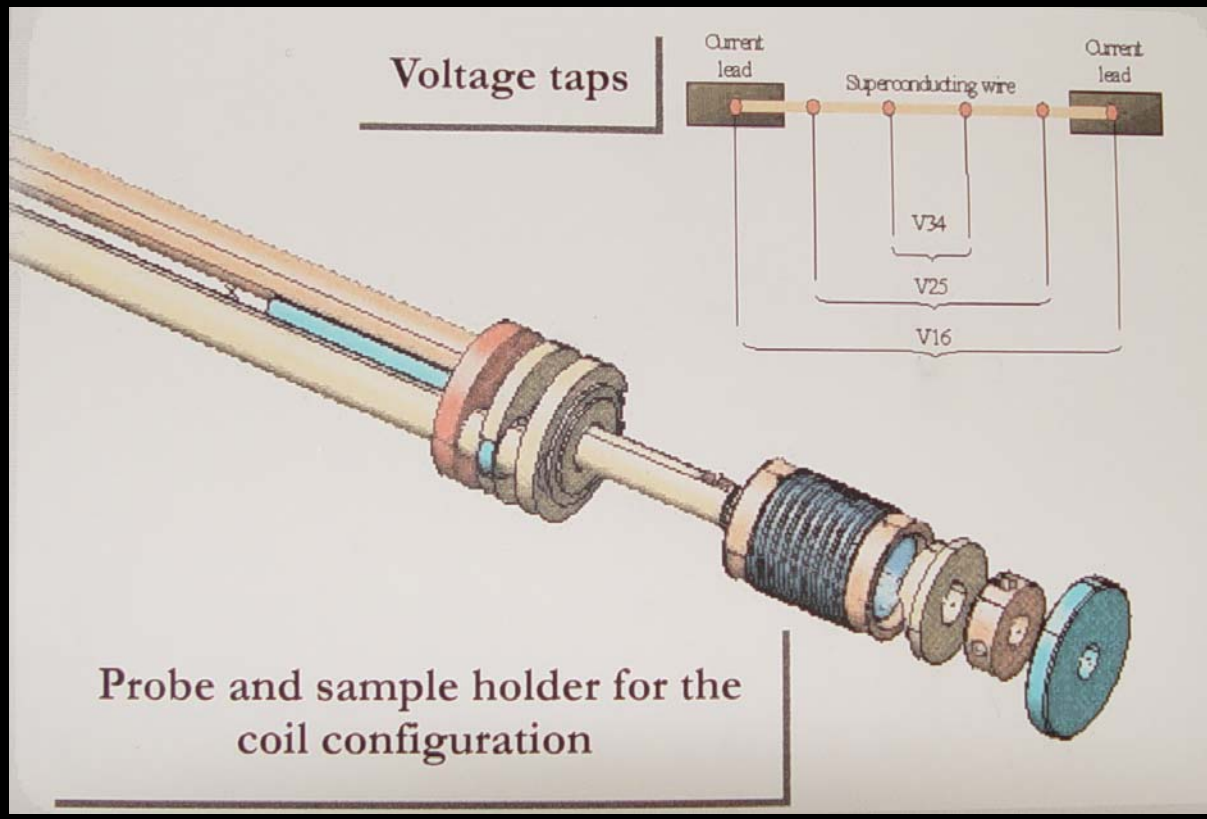
- Introduction
- Experimental equipment
- Data analysis
- Conclusions

Cable Cross Section

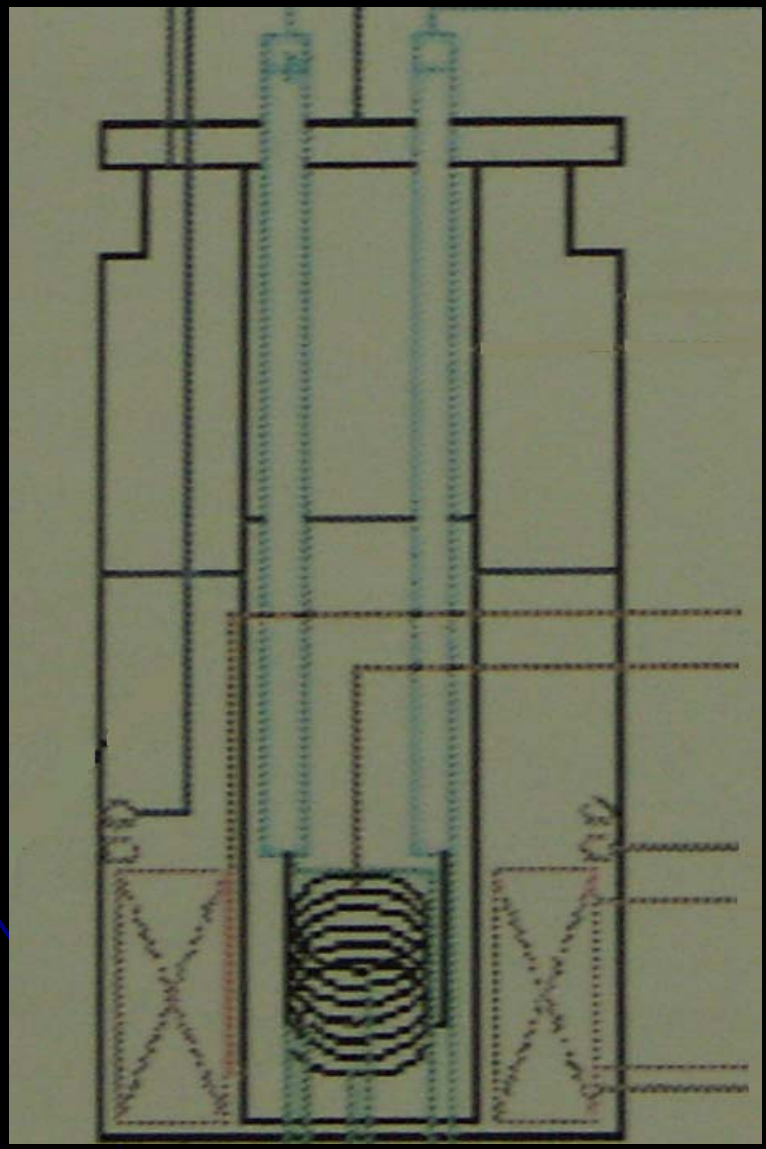


Short Sample Test Facility

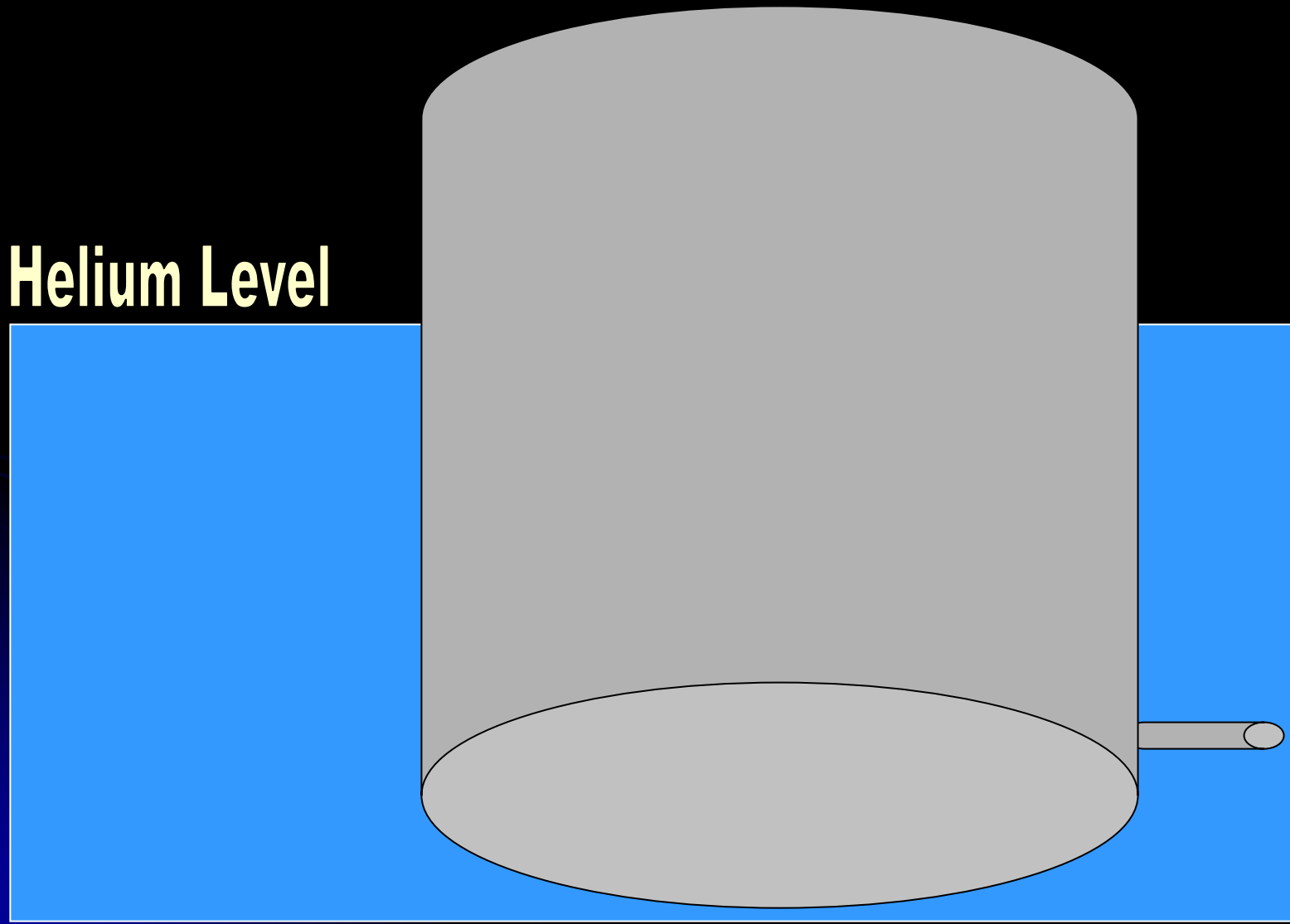




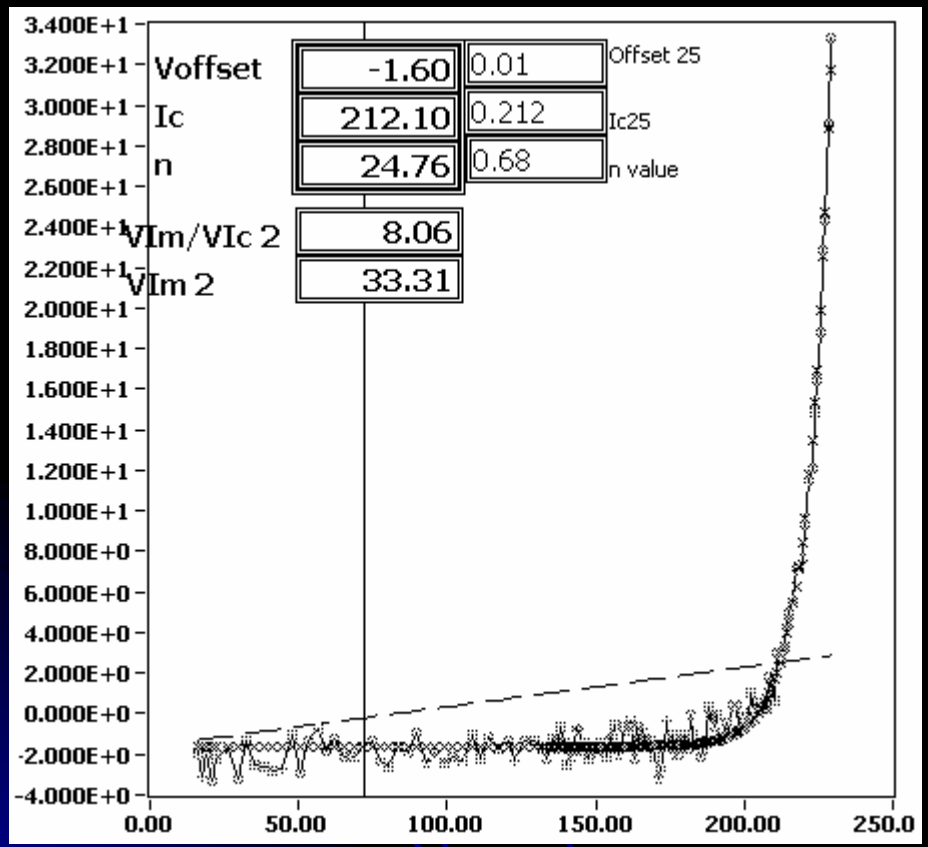
Scheme of Experimental Staff

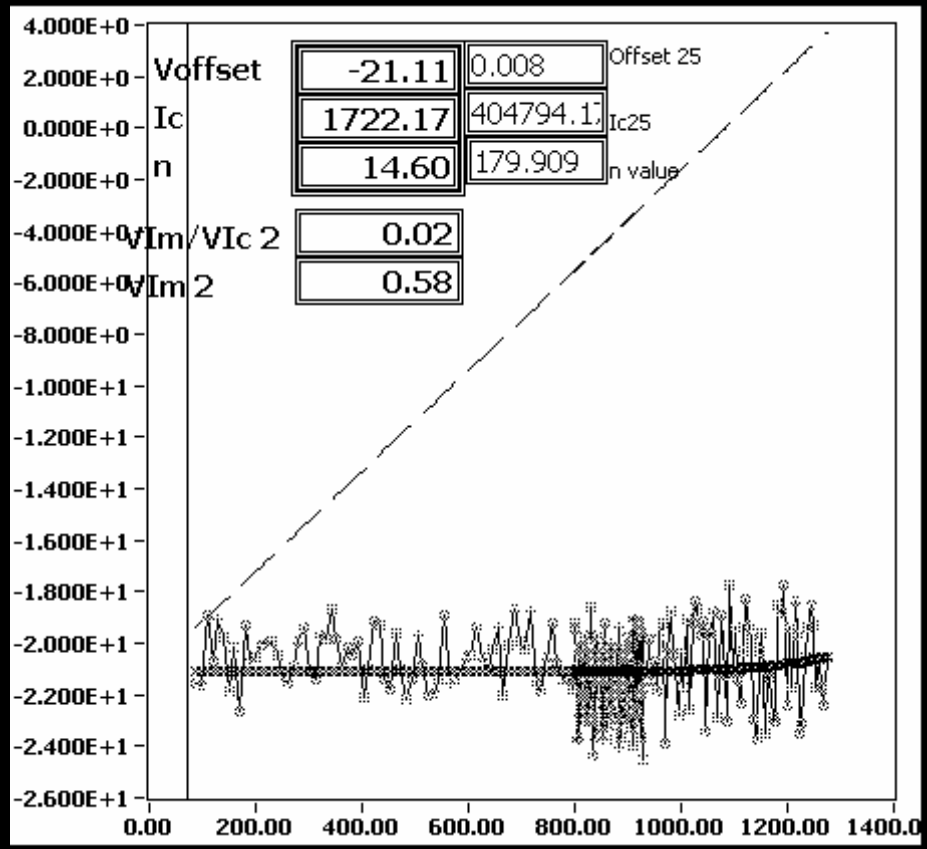


VTI Bath

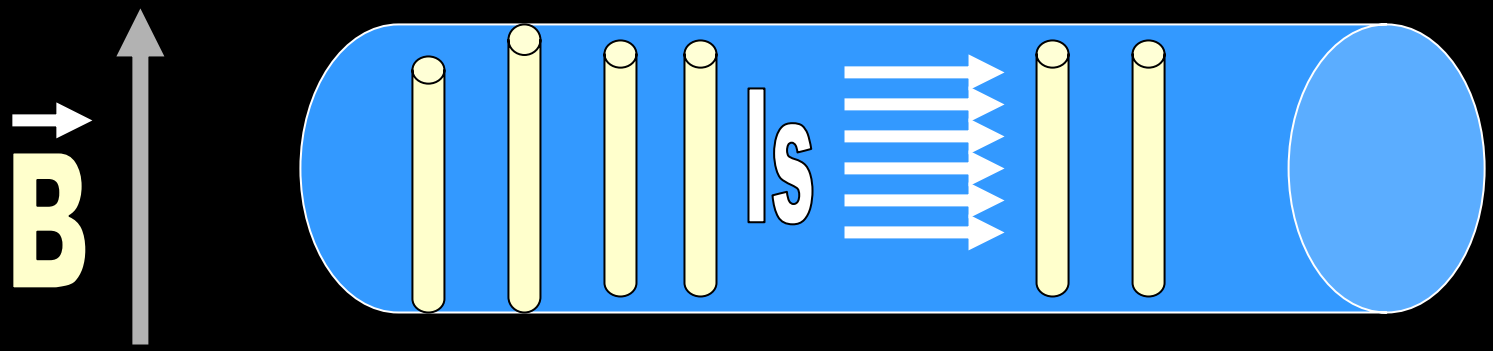


Experimental Data





Theoretical Explanation

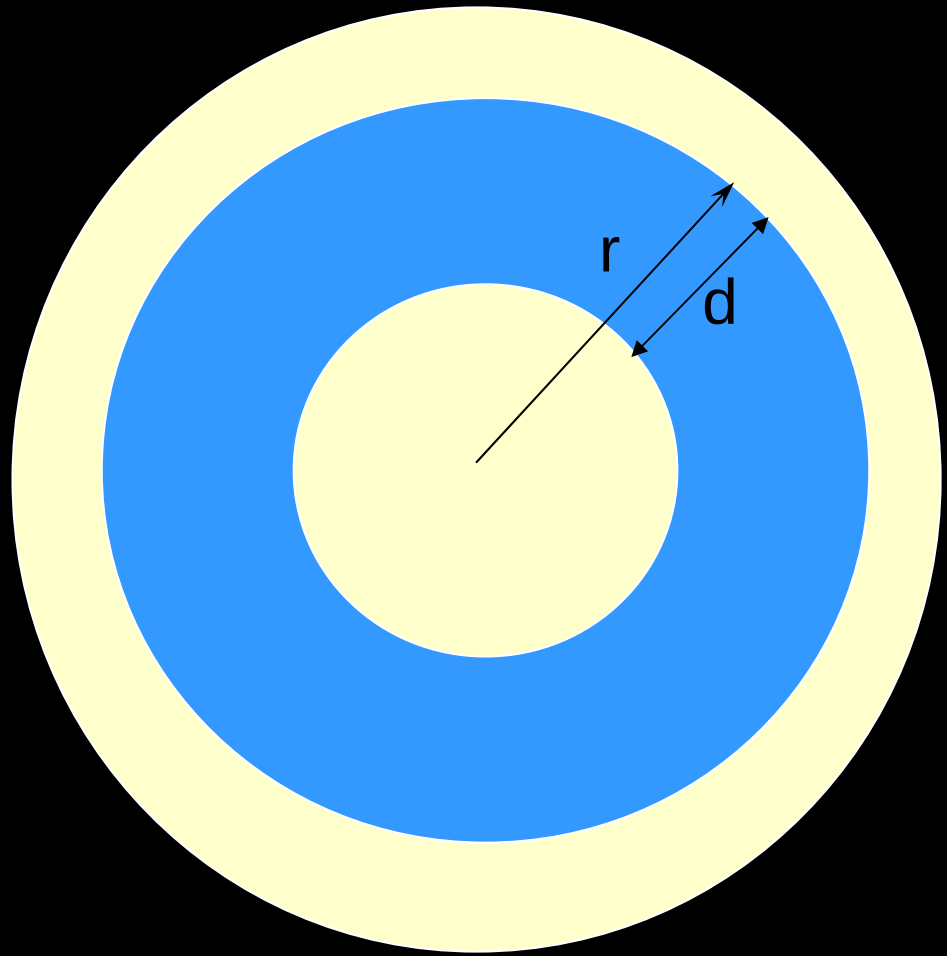


Vortexes appear between Bc1 and Bc2 in second type superconductor parallel to the magnetic field

Theoretical assumptions

Net vortex length considered to be ~3d

Vortex radius ~2λ



Theoretical Explanation

Resistance appears when

$$I_R = nj_C(2\pi rd - 3d2\lambda N)$$

Number of vortexes

$$\frac{dN_V}{dS} = \frac{2B}{\phi_0} = \frac{4Be}{hc}$$

$$N = \frac{dN_V}{dS} 2\lambda 2\pi r$$

$$I_R = 2\pi nj_C rd(1 - \frac{48Be\lambda^2}{hc})$$

Theoretical explanation

Strand quenches, when quench areas in filaments become unstable and grow infinitely. It happens when filament temperature equals T_c

Coefficient of thermal conductivity in filament area

$$\begin{pmatrix} \kappa_1 & 0 \\ 0 & \kappa_2 \end{pmatrix}$$

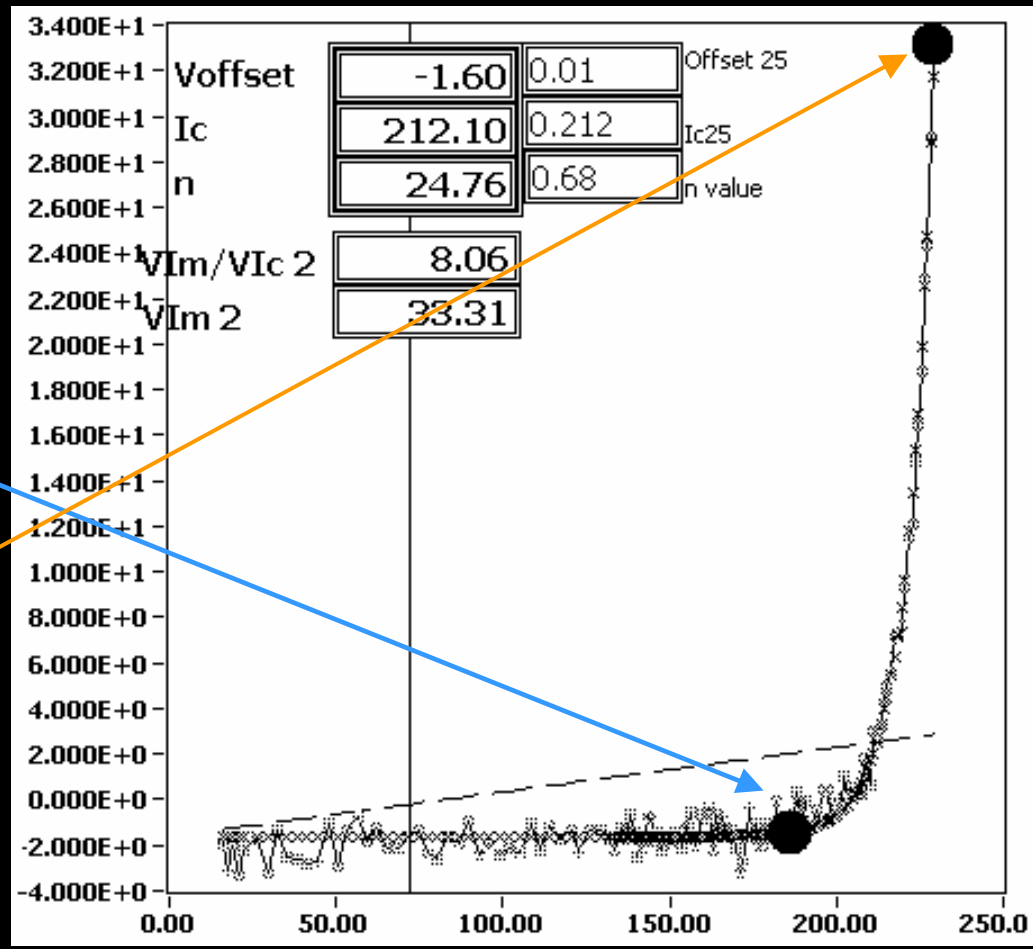
$$\frac{2r}{\kappa_1} = \frac{2(r-d)}{\kappa_{Cu}} + \frac{2d}{\kappa_{Nb}} + \frac{4}{\alpha}$$

$$\kappa_2 = \frac{(r-d)^2}{r^2}\kappa_{Cu} + \frac{2d}{r}\kappa_{Nb}$$

Theoretical Speculations

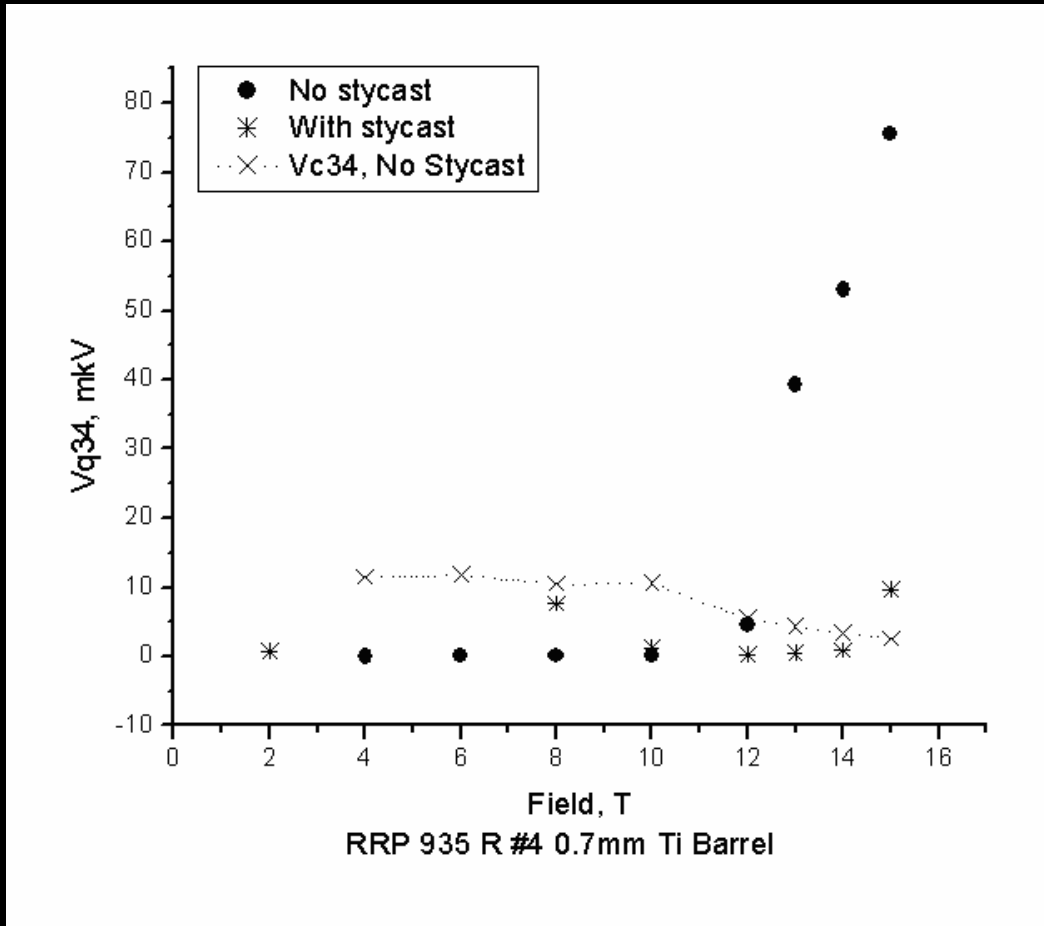
There are two basic points at Volt-Ampere characteristic

- Resistance Appearance
- Quench

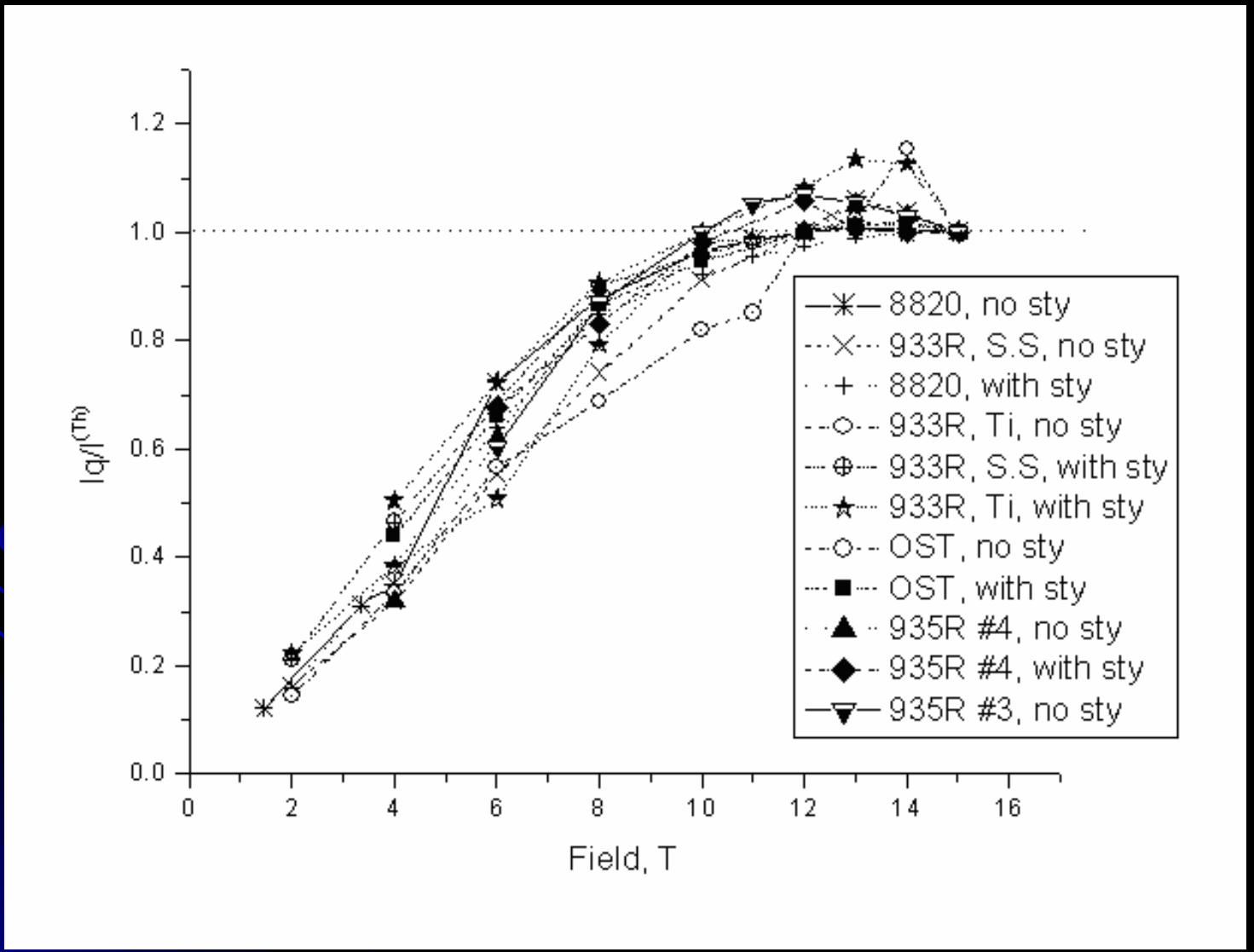


Field dependence of quench

- In high fields Vq higher in sample with stycast
- In high fields Vq difference increases with field
- There is no difference in Vq, when dependence is flat



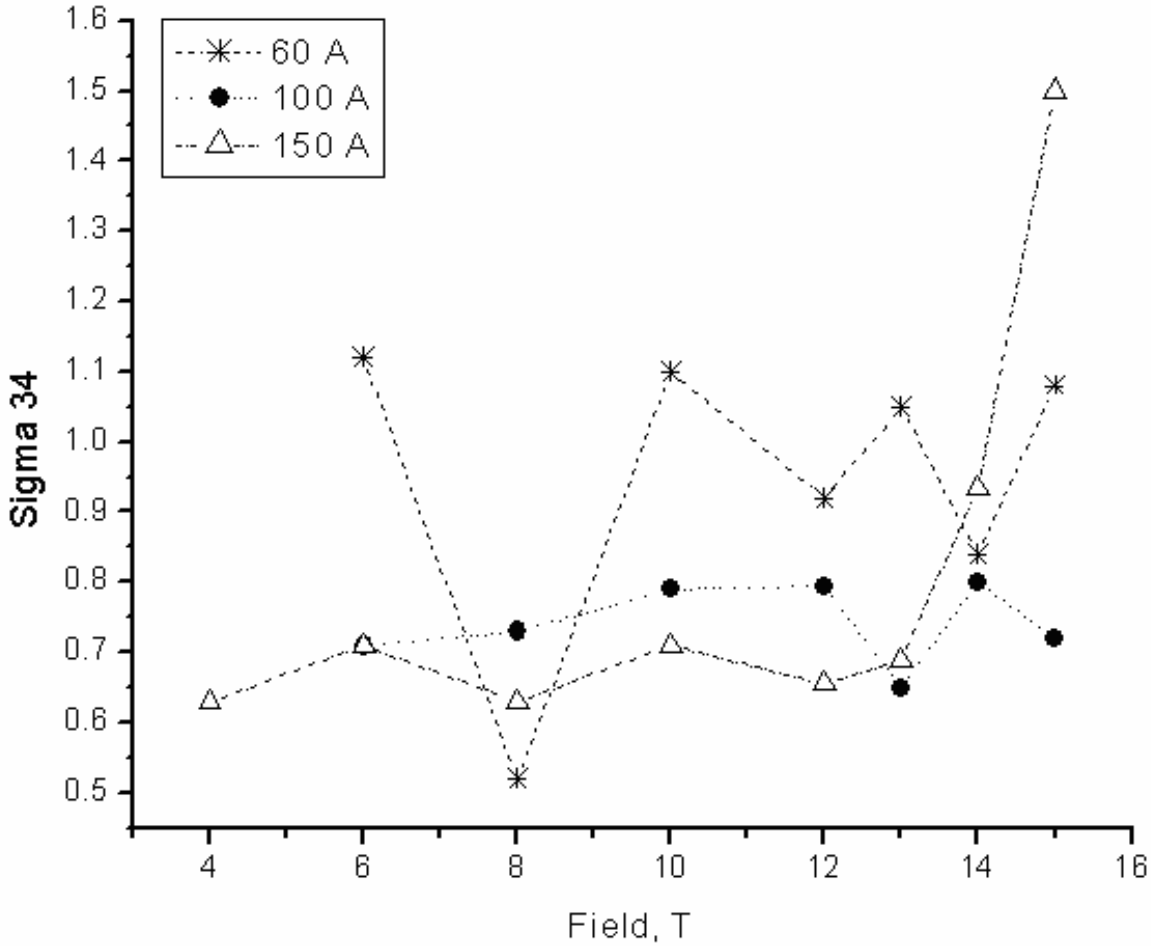
Summers Approximation



Theoretical speculations

- The main pinning centers are mechanical defects, which number decreases in stycast due to mechanical stabilization
- Once the dependence is flat, there is no many vortexes, so quench appears due to DC and stycast does not effect the experiment
- Increasing of field leads to the increasing of number of breaks in wire, so appears a bigger Vq difference in sample with stycast
- In low fields all the dependences are similar, so quench point is a material property

Standard Deviation



Future work

- Measure deviation of Iq in low fields for one sample (several measurements for each point)
- Make a computer modeling in order to proof theoretical speculations

Conclusions

- SSTF methods were learned
- Program for data acquisition was developed